

INDOOR AIR QUALITY ASSESSMENT

**Massachusetts Department of Mental Retardation
Hogan Regional Center, 3 Hathorne Circle
Village of Hathorne, Danvers, Massachusetts**



Prepared by:
Massachusetts Department of Public Health
Center for Environmental Health
Bureau of Environmental Health Assessment
Emergency Response/Indoor Air Quality Program
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Background/Introduction

At the request of Faith Kirkland, Labor Relations Specialists, Massachusetts Department of Mental Retardation (MDMR), Northeast Region and Mark D'Angelo, Deputy Director, Office of Employee Relations, the Massachusetts Department of Public Health (MDPH), Center for Environmental Health (CEH), Bureau of Environmental Health Assessment (BEHA) provided assistance and consultation regarding indoor air quality concerns at the Hogan Regional Center (HRC), 3 Hathorne Circle, Village of Hathorne, Danvers, Massachusetts. Concerns of microbial growth and water infiltration in the building prompted the request.

On April 1, 2004, a visit to conduct an indoor air quality assessment was made to this building by Cory Holmes, Environmental Analyst of BEHA's Emergency Response/Indoor Air Quality (ER/IAQ) Program. Marilyn Tarmey, Labor Relations Specialists, MDMR, Robert Hyde, Director of Core Services, HRC and Ms. Kirkland accompanied Mr. Holmes during the assessment.

The HRC is a two-story brick building with basement constructed in the late 1960's. The HRC contains patient units, administrative offices and a day program. Each floor, including the basement, is accessible by four stairwells. The basement contains several large open rooms, one of which is used for storage of unused office equipment (e.g., computers, shelving) and the boiler plant.

The HRC was previously evaluated by ATC Associates, Inc. (ATC), an environmental consultant, in February 2004. ATC conducted mold and asbestos testing. ATC made recommendations to conduct remedial actions based on their findings:

- Remove and dispose of water damaged porous items in basement.
- Replace basement doors to prevent odor migration into stairwells.

- Seal all pathways between the basement and adjacent areas to prevent odor migration.
- Remove and dispose of all water damaged porous items stored in the 2nd floor storage room.
- Clean and disinfect all surfaces in stairwells.
- Repair/replace water damaged asbestos floor tiles using a Massachusetts licensed asbestos abatement contractor.
- Remove and dispose of water damaged bulletin board on second floor near stairwell #2.
- Identify and repair sources of water intrusion.
- Identify and mitigate water damaged/mold contaminated materials in accordance with EPA guidelines.
- Contact an HVAC engineering firm to provide additional ventilation in basement to place basement under negative pressure in relation to the rest of the building.
- Conduct periodic inspection of mold colonized asbestos-containing pipe insulation in the basement. Remediation of pipe wrap should be conducted by a Massachusetts licensed asbestos abatement contractor.
- Clean basement area utilizing appropriate procedures, once water damaged/mold colonized materials are removed (ATC, 2004).

Methods

BEHA staff conducted a visual inspection for standing water, water-damaged building materials and microbial growth. Air tests for carbon dioxide, temperature and relative humidity were taken with the TSI, Q-Trak, IAQ Monitor, Model 8551.

Results

The building has an employee population of approximately 100 individuals, and an estimated 50 members of the public visit the building on a daily basis. The assessment was conducted on a day of moderate to heavy, driving rain. Tests within the building were taken under normal operating conditions. Test results appear in Table 1.

Discussion

Ventilation

It can be seen from Table 1 that carbon dioxide levels were below 800 parts per million of air (ppm) in all areas surveyed throughout the building, indicating adequate air exchange. Air handling units (AHUs) on each floor provide fresh air. Fresh air is supplied to occupied spaces by ceiling mounted air diffusers (Picture 1), which are connected to AHUs via ductwork. Air is exhausted through ceiling mounted return vents (Picture 2) connected to ductwork. These systems were operating during the assessment.

To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of occupancy. In order to have proper ventilation with a mechanical supply and exhaust system, the systems must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. The date of the last balancing of these systems was not available at the time of the assessment. It is recommended that HVAC systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994).

The Massachusetts Building Code requires a minimum ventilation rate of 20 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room

(SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week, based on a time-weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches. For more information on carbon dioxide see [Appendix A](#).

Temperature readings were measured in a range of 68° F to 75° F, which were close to the BEHA recommended comfort range. The BEHA recommends that indoor air temperatures be maintained in a range of 70° F to 78° F in order to provide for the comfort of building occupants. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply.

Relative humidity measurements ranged from 36 to 54 percent, which were slightly below the BEHA recommended comfort range in some areas surveyed. The BEHA recommends a comfort range of 40 to 60 percent for indoor air relative humidity. During the heating season, relative humidity levels would be expected to drop below the recommended comfort range. The sensation of dryness and irritation is common in a low relative humidity environment. For buildings in New England, periods of low relative humidity during the winter are often unavoidable.

Microbial/Moisture Concerns

The basement appears prone to repeated flooding. Moisture sources and water-damaged materials were identified in the basement during the assessment. The heavy, driving rain helped to identify moisture sources. BEHA staff observed several inches of standing water in stairwell 1 and in several basement areas (Picture 3). The primary area of water intrusion appeared to be in the bottom corner of stairwell 1 (Picture 4).

Portions of the basement are used for storage. Because of standing water, some of the stored items were moistened. Porous materials that can support mold growth, such as wooden pallets, pipe insulation, cardboard, paper and shelving appeared to be colonized with mold (Pictures 5-7). The US Environmental Protection Agency and the American Conference of Governmental Industrial Hygienists (ACGIH) recommend that porous materials be dried with fans and heating within 24 to 48 hours of becoming wet (US EPA, 2001; ACGIH, 1989). If porous materials are not dried within this time frame, mold growth may occur. Water-damaged porous materials cannot be adequately cleaned to remove mold growth. The application of a mildewcide to moldy porous materials is not recommended.

In addition, musty odors and visible mold growth were detected on the ceiling and walls of stairwell 2 (Picture 8). Building materials like cement and concrete are not conducive to mold growth; however, dirt, dust and other debris that accumulate on the surface of these materials can provide a medium for microbial growth, especially if moistened repeatedly (e.g., condensation from extended periods of high relative humidity). BEHA staff recommended that the surface mold in these areas be vacuumed with a high efficiency particulate arrestance (HEPA) filtered vacuum cleaner, followed by disinfection with a one to ten bleach and water solution.

Potential means for the movement of basement/stairwell odors and particulates to occupied areas of the building were also identified. The most obvious pathway is the basement/stairwell doors. Fire doors to the upper floor marked “Keep Closed” were found propped open (Picture 9). Stairwell doors should remain closed to minimize airflow into the main hallway. In addition, the metal doorway at the bottom of stairwell 1 was severely corroded. As a result, spaces exist under the doorframe. These spaces allow odors and particulates to move from the basement to occupied areas. This condition is augmented by a condition known as the stack effect.

The stack effect is experienced when airflow in buildings rises from lower to upper floors. Stairwells are prone to this condition due to temperature and pressure differentials. As airflow is created, airborne particulate matter and odors can migrate to occupied areas of the building. Exhaust/return vents located near stairwell doors at the ends of the second floor hallway facilitate odor migration (Picture 10). As the return vents draw air, the ends of the hallway become depressurized. As a result, odors from the stairwell are drawn through spaces beneath the stairwell door and into occupied areas. Other potential pathways for particulate/odor migration include utility holes, floor cracks and other penetrations (Picture 11).

The HRC also has a history of chronic roof leaks. A number of areas on the second floor showed signs of water damage. Stained walls, corroded metal ceiling panels, peeling paint and efflorescence were noted (Pictures 12-14). Efflorescence is a characteristic sign of water damage to building materials, but it is not mold growth. As moisture penetrates and works its way through building materials (e.g., plaster), water-soluble compounds dissolve, creating a solution. As this solution moves to the surface, the water evaporates, leaving behind white, powdery mineral deposits. MDR officials reported that funding for roof repair is part of a planned capital repair project.

Conclusions/Recommendations

The conditions present within the HRC require three distinct remediation activities: A) remediation to prevent water sources from entering the building, B) remediation/cleaning of stored materials in the basement and C) general indoor air quality recommendations. The recommendations made in the ATC report dated March 16, 2004 should also be implemented. The following additional recommendations are made as a complement to the ATC recommendations (ATC, 2004).

A) Building Envelope/Water Intrusion

1. Continue with plans to replace roof. Once the roof is repaired, repair/replace water damaged plaster and ceiling tiles in a manner consistent with recommendations in the EPA's "Mold Remediation in Schools and Commercial Buildings" (US EPA, 2001).
2. Consult with an architect and/or general contractor about the integrity of the building envelope, especially in regards to water penetration through walls and the foundation.

B) Mold Colonized Materials Located within the Basement

1. Discard stored materials and building materials that appear to have mold contamination. This measure will remove actively growing mold colonies that may be present. Remove mold contaminated materials in a manner consistent with recommendations in “Mold Remediation in Schools and Commercial Buildings” published by the US Environmental Protection Agency (US EPA, 2001). Copies of this document can be downloaded from the US EPA website at: http://www.epa.gov/iaq/molds/mold_remediation.html. Please note that removal of pipe insulation containing asbestos would be subject to federal and state asbestos removal and disposal laws and regulations.
2. As part of remediation, seal the basement off from the stairwell with a temporary impermeable barrier (e.g., wood, gypsum wallboard). Ensure barrier is as airtight as possible by sealing edges and frames with polyethylene plastic and duct tape. Inspect for drafts and/or light penetration to ensure airtight integrity.
3. Use local exhaust ventilation and isolation techniques to control remediation pollutants. Precautions should be taken to avoid the re-entrainment of these materials into the building.
4. Vacuum surface mold in the stairwell with a (HEPA) filtered vacuum cleaner, followed by disinfection with a one in ten bleach solution.
5. Establish communications between all parties involved with remediation efforts, including building occupants, to prevent potential IAQ problems.

6. Develop a notification system for building occupants to report remediation related odors and/or issues to the building administrator. Have these concerns relayed to the contractor and/or contact person in a manner that allows for a timely remediation of the problem.
7. Schedule projects which produce large amounts of dusts, odors during unoccupied periods, when possible.
8. Relocate susceptible persons and those with pre-existing medical conditions (e.g., asthma) away from the general areas of remediation until completion, if possible.

C) General Air Quality Recommendations

1. Use windows to supplement the introduction of fresh air. Open windows on both sides of the building to provide cross ventilation.
2. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, continue to use the HEPA filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).
3. Continue to change filters for air handling equipment as per manufacturer's instructions, or more frequently if needed.
4. Install weather-stripping around and door sweeps beneath stairwell doors to prevent potential odor entrainment.

5. Seal holes in the floors, walls and ceilings for pipes and cables to prevent infiltration of basement pollutants.
6. Refer to resource manuals and other related indoor air quality documents for further building-wide evaluations and advice on maintaining public buildings. These materials are located on the MDPH's website at <http://www.state.ma.us/dph/beha/iaq/iaqhome.htm>.

References

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Picture 1



Ceiling-Mounted Supply Air Diffuser

Picture 2



Ceiling-Mounted Return/Exhaust Vent

Picture 3



Long-View of Water Accumulation in the Basement

Picture 4



Point of Water Intrusion in Bottom Corner of Stairwell 1

Picture 5



Water Damage/Mold Colonized Wooden Shelving in Basement

Picture 6



Water Damage/Mold Colonized Wooden Door in Basement

Picture 7



Mold-Colonized Pipe Insulation in Basement

Picture 8



Mold Growth on Surface of Stairwell Ceiling

Picture 9



Fire Door to Second Floor Found Propped Open

Picture 10



Proximity of Return Vent to Stairwell Door, Note Space beneath Door

Picture 11



Open Utility Hole in Stairwell/Basement

Picture 12



Active Roof Leak on Second Floor, Note Missing Tiles and Plastic Covering Items

Picture 13



Water Stained Office Material on Second Floor

Picture 14



Peeling Paint and Efflorescence in Second Floor Storeroom

TABLE 1
Indoor Air Test Results – Hogan Regional Center, 3 Hathorne Circle

April 1, 2004

Location	Carbon Dioxide (*ppm)	Temp. (°F)	Relative Humidity (%)	Occupants in Room	Windows Openable	Ventilation		Remarks
						Supply	Exhaust	
Outside (Background)	414	52	79					NE winds 25-30 mph, moderate to heavy rain
Stairwell 2	652	70	44		N	N	N	Visible mold growth on ceiling surface, musty odors, fire door propped open
Basement	501	68	54			Y	Y	Visible mold growth, musty odors, severe water damage on porous items, pipe insulation and flat surfaces, utility holes, standing water
Stairwell 1					N	N	N	Point of water intrusion, water accumulation, saturated debris on floor
2 nd Floor Psych Nursing	601	68	51	3	Y	Y	Y	Space under door to stairwell, water damaged wall and metal CTs
RN II Office	590	75	38	3	Y	Y	Y	Water damage/missing CTs, roof drain-leak, plastic and buckets
Break Room	640	74	39	3	N	Y	Y	Efflorescence-corner ceiling
Copy Room					N			Ceiling vent no air flow

* ppm = parts per million parts of air

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred 600 - 800 ppm = acceptable > 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

Table 1-1

TABLE 1**Indoor Air Test Results – Hogan Regional Center, 3 Hathorne Circle****April 1, 2004**

Location	Carbon Dioxide (*ppm)	Temp. (°F)	Relative Humidity (%)	Occupants in Room	Windows Openable	Ventilation		Remarks
						Supply	Exhaust	
2 nd Floor Hallway								Water damaged/missing tiles, water damaged corkboard-discard
NRS Storage Room					N		Y	Water damaged ceiling plaster, no draw from exhaust vent
NRS	790	71	36	3	Y	Y	Y	

* ppm = parts per million parts of air

Comfort Guidelines

Carbon Dioxide - < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems

Temperature - 70 - 78 °F

Relative Humidity - 40 - 60%

Table 1-2